INSTRUCTION BOOK
— and —
MAINTENANCE MANUAL

FOR

Radiological Survey Meter

FCDA ITEM NO. CD V-700 MODEL 3

INTERNATIONAL PUMP MODEL IP-700

INTERNATIONAL PUMP AND MACHINE WORKS

LIVINGSTON, NEW JERSEY

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Illustrations

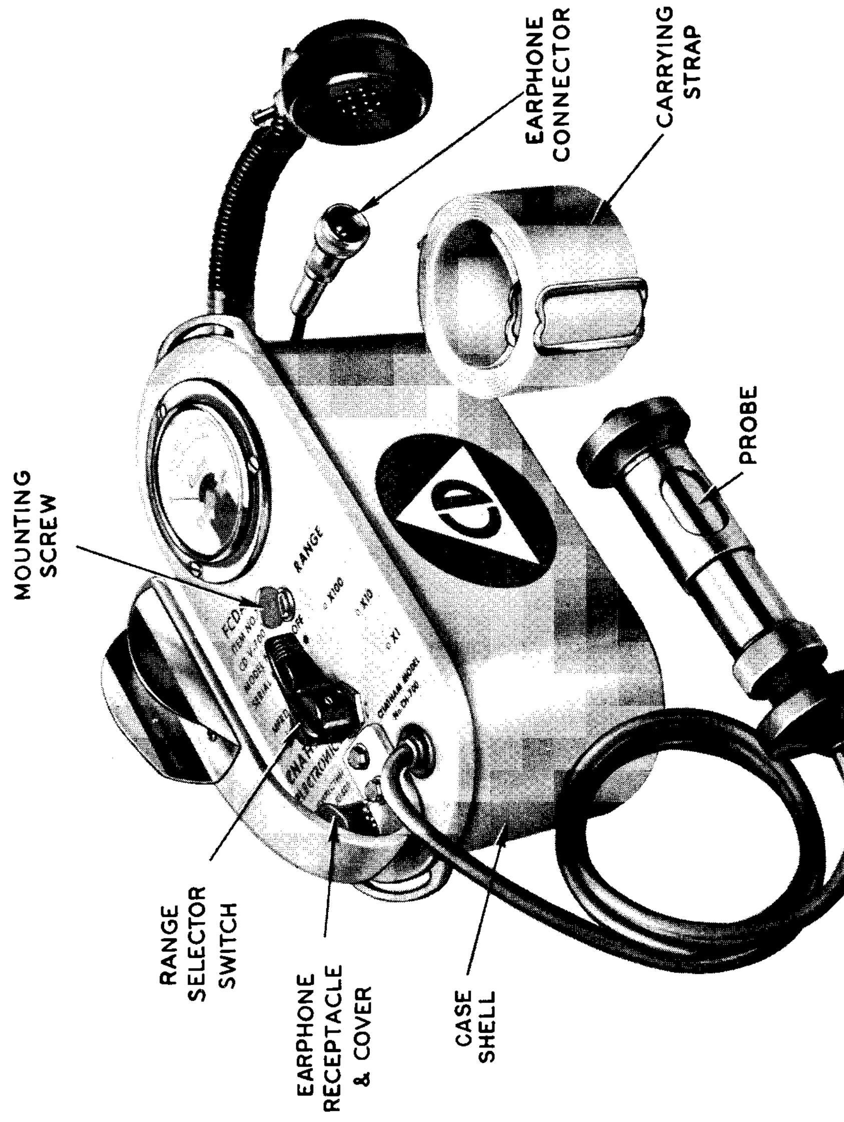


FIGURE 1 RADIOLOGICAL SURVEY METER CD V-700

INSTRUCTION MANUAL

1.0 GENERAL DESCRIPTION

The CD V-700 is a portable radiological survey meter used to measure low-intensity gamma radiation fields and to detect the presence of beta radiation The three ranges provide full scale indications in fields of 0.5, 5.0, and 50 milliroentgens per hour. The accuracy when measuring the gamma radiation from Cobalt 60 or Radium is within ±10% of true dose rate. Its operating temperature range is from −20°F to 125°F and is unaffected by altitude changes up to 25,000 feet. The instrument is completely ruggedized and designed to operate under adverse field conditions. One set of batteries provide a minimum of 100 hours of continuous operation.

The survey meter consists of a probe, earphone, top cover assembly and case shell. The high voltage supply, pulse leveling and metering circuit, and batteries form part of the cover assembly. See figures 1 and 2. A radioactive sample is provided in the bottom of the case shell for testing the operation of the instrument. An adjustable carrying strap permits the operator to suspend the instrument comfortably from the neck or shoulder. The top cover and case shell can be easily separated to provide access to the batteries and circuit components by loosening the single mounting screw located beneath the handle.

The probe is a chrome-plated steel housing connected to the instrument by a 36-inch shielded cable. It contains the thin-walled halogen-quenched Geiger-Mueller tube which serves as the radiation detection element. A movable shield on the probe permits detection of beta radiation by directly exposing the tube. With the probe window closed, the housing will completely absorb beta radiation of energies less than 2.5 MeV.

The earphone, when connected to the phone receptacle on the cover, provides the operator with an audible signal in the presence of a radiation field. It is a single-piece magnetic-type device with a connector for the sealed jack on the cover.

2.0 THEORY OF OPERATION

The Geiger-Mueller tube consists of a thin cylindrical shell which serves as the cathode, a fine wire anode suspended along the axis of the shell, and a gas mixture which includes a halogen quenching agent. A voltage slightly less than that required to produce a discharge is applied between the anode and cathode. When the tube is subjected to a radiation field, some of the energy of the field is absorbed by the walls of the tube causing electrons from the walls to be ejected into the gas volume. As these electrons are accelerated toward the anode by the electric field, collisions with the gas molecules result in the rapid creation of additional ions thus producing a discharge in the gas. The small amount of halogen in the tube serves to help quench the discharge and restore the tube to its original condition awaiting the next ionizing event. This process results in a pulse in the external cir-

cuit. The frequency of such pulses is proportional to the magnitude of the radiation field.

The high voltage supply consists of a "flyback" type circuit which utilizes a relaxation oscillator to periodically drive the high voltage generating pentode to cut-off. The relaxation oscillator consists of a glow tube V5, resistor R19, and capacitor C11. See figure 4 for schematic diagram. The oscillator pulses have an amplitude of 18 to 25 volts and are capacitively coupled to the grid of V6. The plate current of V6 flows through the high voltage coil L1. When V6 is cut off by the oscillator pulses, the collapsing of the magnetic field in the coil produces voltage pulses of

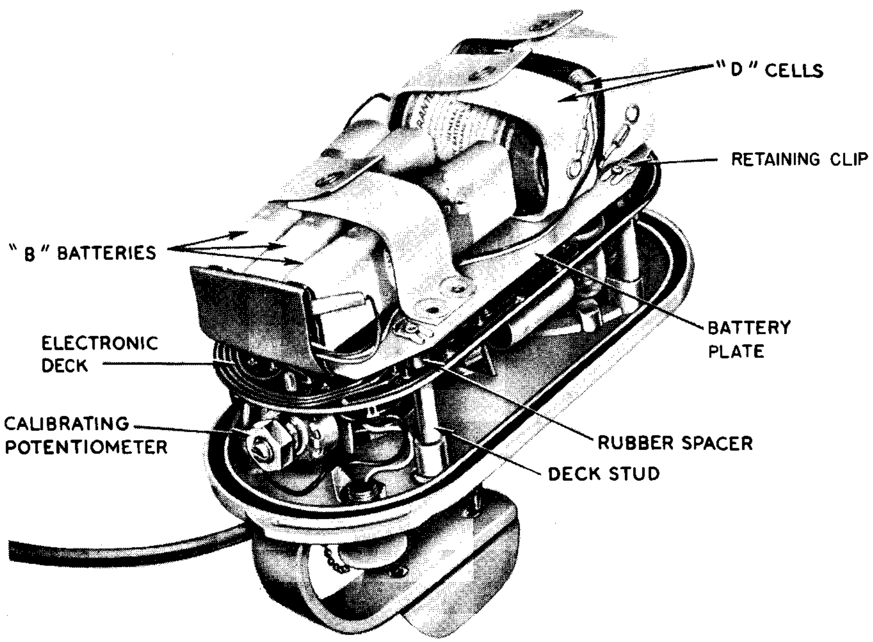


FIGURE 2. TOP COVER ASSEMBLY WITH CASE SHELL REMOVED

approximately 900 volts. These are coupled to the screen grid of V7 through capacitor C13. V7 acts as a diode to rectify the high voltage pulses so that a d-c voltage of approximately 760 volts, negative with respect to ground, results. Resistor R17 feeds this voltage back to the grid circuit of V6 where it is compared with the reference voltage of glow tube V5. As a result of this degenerative feedback the high voltage remains essentially constant throughout normal changes in battery voltages.

V2 and V4 comprise the essential components of a univibrator circuit. In the absence of an input signal from the Geiger tube, V2 is normally conducting while V4 is biased beyond cut-off. Therefore meter M1 in the plate circuit of V4 reads zero. A negative pulse from Geiger tube V1 is coupled to the grid of V2 by means of capacitor C2. This negative signal

cuts V2 off causing a rapid increase in the plate voltage of V2. This positive voltage pulse is introduced to the grid of V4 through one of the range capacitors (C5, C6 or C7) causing V4 to conduct heavily. The conduction time of V4 is determined by the time constant of the V2 plate-to-V4 grid coupling network. The plate current through V4 produces a reading on meter M1. The current pulses through the meter are integrated by capacitor C4 and the average current indicated on the meter is proportional to the frequency of the pulses through V4. This pulse frequency is in turn proportional to the frequency of pulses from the Geiger tube. Therefore, the meter can be calibrated to read the magnitude of the radiation field directly in milliroentgens per hour. Range switching is accomplished by switching C5, C6 or C7 into the circuit, thereby changing the time constant of the V2 plate-to-V4 grid coupling network.

The earphone is connected to the pulse shaping circuit through the network R8, R9 and C3 and provides an audible indication of the presence of radiation.

3.0 INSTALLATION

3.1 Battery Installation and Replacement

The instruments are shipped with the batteries removed. In order to put the instrument into operation the batteries must be installed in the following manner:

1. Loosen the mounting screw and lift the top cover from the case shell to expose the battery plate. See figure 2.
2. Close the middle 1½-volt "D" cell battery strap snap fastener.

Note

The "D" cell battery straps must be closed before inserting the batteries.

3. Insert the button contact which forms the positive terminal of the "D' cell into the holder cup terminal on the battery strap.
4. Press the negative side of the battery into the strap until the negative battery strap contact slips into the center of the negative side of the battery. The battery strap will also make contact with other types of batteries that have a recess on the negative side.
5. Insert the second "D" cell in the end strap in the same manner.
6. Open the retaining strap for the "B" batteries and press the contacts of the three 45-volt cells into the snap terminals provided. The contacts will not fit into the terminals unless their polarity is correct. The positive terminals of the two outer batteries and the negative terminal of the center battery must be on top.

Note

The retaining strap must be open while the "B" batteries are being inserted.

7. With the 45-volt battery terminals firmly seated, secure these batteries by closing the snap fastener on the retaining strap.

8. Replace the top cover assembly in the case and tighten the mounting screw.

The batteries can be easily removed by opening the snap fasteners on the battery straps and taking the cells out of the contact terminals.

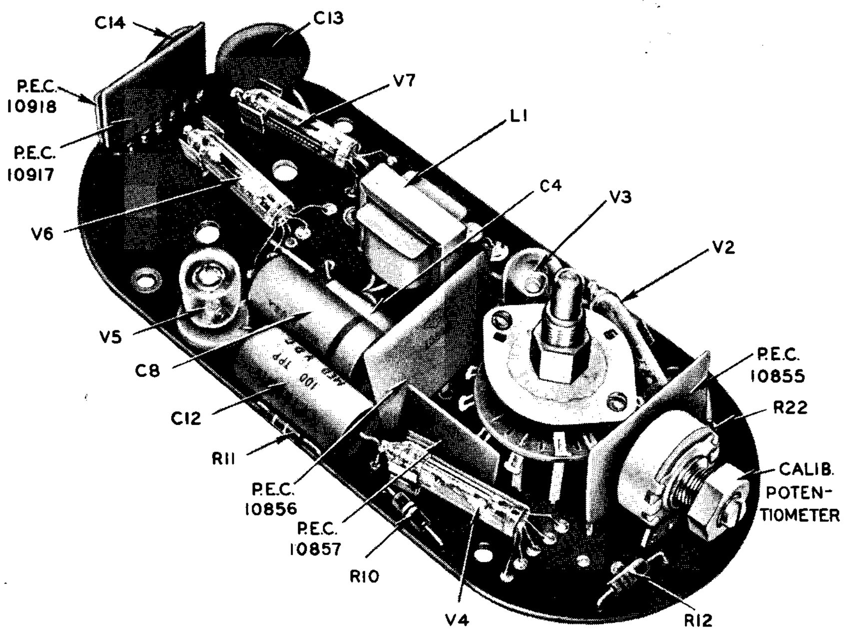


FIGURE 3 ELECTRONIC DECK ASSEMBLY

3.2 Carrying Strap

Insert one end of the strap through the slots provided in the top cover and then through the adjusting slides. Adjust, so the instrument hangs comfortably from the shoulder or neck.

3.3 Earphone

Connect the earphone to the receptacle provided on the cover.

4.0 OPERATION

4.1 General

The selector switch constitutes the only control required for the operation of the instrument. After the batteries and carrying strap are installed, the instrument is set into operation by rotating the selector switch clockwise to any of the range positions.

4.2 Operation Check

The selector switch should be turned to the X-10 range with the beta shutter in the fully closed position. If no external radiation is present, no deflection will be obtained on the meter. The beta shield should now be rotated to the fully open position and the probe placed as close as possible to the radioactive sample located in the bottom surface of the case. The open area of the probe must be directly facing the radioactive sample. The meter should indicate approximately 2 milliroentgens per hour (mr/hr). This procedure can serve as a calibration check in the field if no external source of radiation is present. When it is necessary to replace a major component, the test sample can be used to recalibrate the instrument if an accurately known field is not available. However, to achieve the fullest accuracy a known field should be used as described in paragraph 7.7.

4.3 Determination of a Radiation Field

The selector switch should first be set on the X-100 range. If no deflection is noted it should be turned to the X-10 range. If there is still no deflection the switch should be set on the X-1 range and left on this range until an off-scale reading is obtained. When this occurs the next higher range should be selected until an on-scale reading is obtained. In all cases, the magnitude of the radiation field is given by the product of the meter reading and the scale multiplier.

EXAMPLE: Assume a reading of 0.25 is obtained on the middle or X-10 range. The radiation field is 0.25×10 or 2.5 mr/hr.

The instrument is sufficiently sensitive to respond to normal background radiation. Therefore a deflection will always be obtained on the X-1 range. The magnitude will depend upon the level of the background radiation in the immediate vicinity.

4.4 Use of the Earphone

The earphone cable is provided with a socket that mates with the plug on the top cover. When not in use, this plug is protected by a plastic cap which is attached to the cover by a chain.

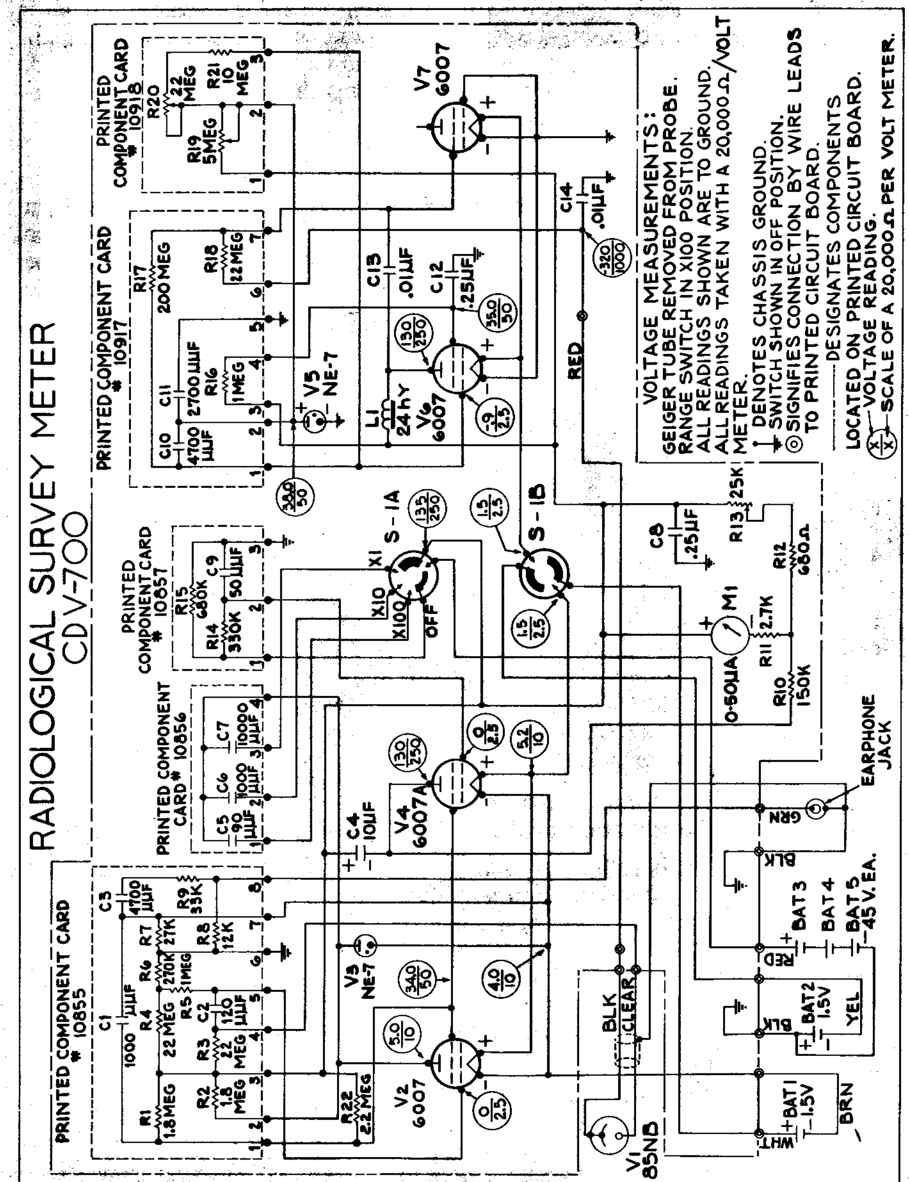


FIGURE 4 SCHEMATIC DIAGRAM

5.0 OPERATORS MAINTENANCE

5.1 Batteries

The operator should not attempt any maintenance beyond replacement of batteries or the Geiger tube. When the instrument is to be stored for any period of time the batteries should be removed to prevent damage to the instrument due to deterioration of the batteries.

5.2 Radioactive Contamination

In case of contamination, the instrument can be cleaned by a cloth dampened in a mild soap solution.

6.0 PREVENTIVE MAINTENANCE

6.1 Monthly Check

If the instrument has been stored with batteries, they should be removed and the contacts carefully cleaned to remove any dirt or corrosion. The batteries should then be reinserted in accordance with paragraph 3.1 with particular care taken to obtain proper contacts on all connections. The instrument should then be checked in accordance with paragraph 4.2.

6.2 Yearly Check

The monthly check described in paragraph 6.1 should be repeated. Unsatisfactory batteries should be replaced immediately. The gaskets should be inspected for any signs of deterioration. The calibration of the instrument should be checked in accordance with paragraph 7.7.

7.0 CORRECTIVE MAINTENANCE

7.1 General

Improper operation of an instrument will be indicated by its failure to respond properly to the procedure described in paragraph 4.2. The cause will most frequently be found in the batteries or the battery connections. Therefore the battery voltages should be checked (see paragraph 7.2) and the battery connections carefully examined to insure that proper contact is being made.

7.2 Battery Check

A conventional 20,000 ohms per volt voltmeter can be used to measure the battery voltages. This measurement must be made under load conditions with the selector switch in any of the range positions. The "D" cells can be measured individually and should provide a minimum of 1.0 volts. The cells which comprise the "B" battery cannot be measured individually in any convenient manner and therefore must be measured in series. This is easily done by connecting the voltmeter leads across the solder lugs extending from each side of the battery terminal strip. A minimum of 110 volts is required for proper operation.

7.3 Replacing the Geiger-Mueller Tube

This instrument utilizes a specially designed, halogen-quenched Geiger-Mueller tube which differs from previous models in that the operating life is unaffected by use and therefore rarely requires replacement. However should this be necessary it can be performed quickly in the field as follows:

1. Remove the probe from the mounting clip which forms part of the handle.
2. Unscrew the cap nut at the base of the probe assembly and by gently pulling on the vinyl bumper ease the plug from the probe shell. This should be done with a slight rotary motion.
3. The tube will now be exposed and can be pulled free from the socket in the base of the plug.
4. The new tube should then be inserted into the socket until it rests firmly on the bottom of the plug. The tube should be handled carefully at either the base or the top section to avoid crushing the thin wall.
5. Using a slight rotary motion, press the plug and tube into the probe shell. The glass point at the top end of the tube should be centered in the probe shell so that it fits into the opening in the vinyl bumper at the opposite end of the probe shell. When this is done the plug will slip in smoothly until the retaining ring for the cap nut is against the probe shell.
6. Tighten the cap nut and check the operation as described in paragraph 4.2.

7.4 Replacement of Circuit Components

If the procedures of paragraphs 7.1, 7.2 and 7.3 do not restore the instrument to proper operation, check the individual circuit components. The normal operating voltages are given in figure 4. When making measurements on the elements of the type 6007 subminiature tube note that the plate lead is nearest the red dot on the tube base with the screen grid, filament (+), control grid and filament (−) following consecutively.

To expose the printed circuit board:

1. Loosen the fastening screw.
2. Lift the top cover assembly free of the case shell.
3. Remove the four battery plate retaining clips (see figure 2).
4. Lift the battery plate from the mounting studs.

The printed circuit board will now be sufficiently exposed to carry out voltage checks. To obtain access to the other side of the board it is necessary to carry out steps 5 through 8.

5. Remove the selector switch knob, lockwasher and nut which hold it to the top cover.
6. Remove the four rubber spacers from the mounting studs.
7. Remove the washers and nuts which fasten the meter studs to the printed circuit board.

8. The entire printed circuit board including the selector switch can now be rotated to provide access to any of the components on the upper side.

7.5 Checking the High Voltage Supply

If an electrostatic voltmeter is available, measure the voltage from ground to the point on the printed circuit board to which the black lead from the probe cable is soldered. This voltage should be 735 to 800 volts depending upon the condition of the batteries. Using a 20,000 ohms per volt voltmeter on the 1000 volt scale a reading of −300 to −500 volts should result. If the voltage at this point is low, check neon tube V5 (see figure 3) for a visible glow. If this tube is glowing measure the voltages from ground to the elements of the high voltage generating tube V6. If these voltages are not in accordance with the values given in figure 2 replace V6. If these voltages are correct replace V7. Measure the voltage across neon tube V5 if it is not glowing. A voltage of approximately 38 volts indicates a faulty neon tube which should be replaced. When replacing either neon tube V5 or V3, the anode of the tube should be connected to the + terminal on the printed circuit board.

A less frequent cause of failure of the high voltage supply is high voltage coil L1 and the probe cable. The coil can be checked by measuring its d-c resistance which should be approximately 3000 ohms. The core should be examined carefully for signs of cracks.

The probe cable can be quickly checked by measuring the high voltage with the black and clear probe leads unsoldered from the printed circuit board and noting whether this restores the high voltage.

7.6 Checking the Pulse Shaping and Integrating Circuit

If this section of the circuit is operating properly an audible indication will be provided in the earphone when the control grid of V2 is touched with an insulated screw driver and a meter reading will result with the instrument on the X-1 range. If no audible signal occurs, measure the voltage from ground to filament (−) of V2. If the measured value is not 5.2 volts on the 10 volt scale of a 20,000 ohms per volt voltmeter, the most probable source of the difficulty is V2 or component card No. 10855. If an audible signal occurs with no meter reading, the difficulty is most likely V4 which should then be replaced. It should be noted that V4 is a tube type 6007A and is distinguished from the 6007 by a green dot on the top of the tube.

Should the meter read off-scale continuously in the absence of a radiation field, measure the voltages from ground to the elements of V2. A high voltage on the plate and low voltage to filament (−) indicates that V2 is not operating properly and should be replaced. If V2 is operating properly remove the "D" cell which powers the high voltage supply to determine whether the difficulty is caused by the high voltage supply. If this is the case, the cause is most likely a defective cable or capacitor C8.

7.7 Calibration

After the replacement of a major component, the instrument can be recalibrated by means of the radioactive sample. However the greatest accuracy is obtained by using a Radium or Cobalt 60 source of gamma

radiation. This source should be capable of providing a uniform field of 25 milliroentgens per hour across the entire probe. Proceed as follows:

1. Loosen the mounting screw located under the handle and lift the top cover assembly from the case shell. The calibrating potentiometer will now be exposed. (See figure 2.)
2. Loosen the locking nut on the potentiometer.
3. With the beta shutter in the fully closed position, place the probe assembly in the known radiation field so that the center of the thin-walled section of the Geiger-Mueller tube is at the 25 milliroentgen per hour position. An imaginary line from the source to the probe should be perpendicular to the major axis of the probe.
4. Set the selector switch on the X-100 range and rotate the potentiometer adjusting screw until the meter reading is exactly 0.25. A clockwise rotation increases the meter reading while a counter-clockwise rotation decreases it. It is not necessary to calibrate the other ranges.
5. Tighten the potentiometer locking nut and replace the top cover assembly in the case shell.
6. Tighten the mounting screw.

If the radioactive test sample is to be used, steps 1 and 2 are identical. The probe should then be placed against the test sample as described in paragraph 4.2 and the calibration potentiometer adjusted until a reading of 0.2 is obtained with the selector switch on the X-10 range.

8.0 PARTS LIST

8.1 Electrical Components

Part	*Type*	*Manufacturer*	*Function*
BAT-1 BAT-2	Battery 1.5V flashlight "D" cell	General #107	Filament voltage
BAT-3 BAT-4 BAT-5	Battery 45V hearing aid type	General #150	Plate voltage
M-1	Meter 0-50μa 2½" dia. plastic sealed and ruggedized	Chatham #10794	Visual indicator
V-1	Tube Geiger-Mueller steel wall halogen quenched	Amperex #85NB	Radiation detector
V-2 V-6 V-7	Tube electron sub-minitaure pentode	Amperex #6007	Univibrator and high voltage circuit elements
V-4		Amperex #6007A	
V-3 V-5	Tube neon regulating	Marshall Electronics #NE-7	Relaxation oscillator circuit elements
L-1	Coil high voltage	Chatham #10799	High voltage generator
SW-1	Switch selecting board mounting	Chatham #10781	Selecting switch for power and ranges
R-1 thru R-9 C-1 thru C-3	Printed component card	Chatham #10855	Univibrator circuitry
C-5 thru C-7	Printed component card	Chatham #10856	Range capacitors
R-14 R-15 C-9	Printed component card	Chatham #10857	Delay network
R-16 thru R-21 C-10 C-11	Printed component card with twin potentiometers	Chatham #10917 & 10918	High voltage circuitry (both cards supplied as one unit)
C-4	Capacitor 10μf 25V	Astron #ET-10-25	Integrating capacitor
C-8 C-12	Capacitor 0.25μf 150V	Pyramid #100-TRR–Special	Filter capacitor Screen by-pass capacitor

C-13 C-14	Capacitor 0.01μf 1500V dcw disc	Centralab #GMV	Coupling capacitor Filter capacitor
R-10	Resistor carbon 150K ±10% ½w	Allen-Bradley #EB	Integrating network
R-11	Resistor carbon 2.7K ±10% ½w	Allen-Bradley #EB	Calibration circuit
R-12	Resistor carbon 680 ohm ±10% ½w	Allen-Bradley #EB	Current limiting resistor
R-13	Potentiometer 25K board mounting	Centralab #26-4294-1	Calibrating control
	Earphone assembly	Chatham #10792	Audible indicator
R-22	Resistor carbon	2.2 Meg. ±20% ½w	Allen-Bradley #EB

8.2 Mechanical Components

Quantity	*Part Description*	*Source*
1	Case	Chatham #10607
1	Cover	Chatham #10602
1	Gasket, cover	Chatham #10859
1	Gasket, meter	Precision #914-37-C-750-70
1	Gasket, mounting screw	Precision #902-3-C-750-70
1	Handle assembly	Chatham #10606
1	Mounting screw	Chatham #10591
1	Connector, phone assembly	Chatham #10797
1	Spacer, connector	Chatham #10782
1	Gasket, connector	Precision #902-7-C-750-70
1	Knob, switch	Davies #2110 Black
1	Boot, switch	R.F. Lab. #H-1268
4	Tubing, deck mounting	Chatham #10783
4	Clip, deck mounting	Chatham #10854
1	Battery deck assembly	Chatham #10603
1	Printed circuit board	Chatham #10852
1	Probe cable, ring, cap nut	Chatham #10584-6
1	Probe sleeve and plug	Chatham #10587-8
1	Probe beta shield	Chatham #10589
1	Dust cover assembly	Chatham #10793
1	Battery wire assembly	Chatham #10790
1	Carrying strap assembly	Chatham #10534
2	Grommet	Federal #1669
4	Tube clip	Bussman #4320
2	Circuit diagram	Chatham #10787
2	Instruction book	Chatham #700-18

8.3 Manufacturers Names and Addresses

Allen Bradley Co., 136 W. Greenfield Ave., Milwaukee, Wis.
Amperex Electronic Corp., 230 Duffy Ave., Hicksville, L. I., N. Y.
Astron Corp., 255 Grant Ave., E. Newark, N. J.
Bussman Mfg. Co., University at Jefferson, St. Louis, Mo.

Centralab, Div. of Globe Union Inc.,
900 E. Keefe Ave., Milwaukee, Wis.
Chatham Electronics, Div. of Tung-Sol Electric Inc.,
630 W. Mt. Pleasant Ave., Livingston, N. J.
Davies, Harry, Moulding Co., 1428 N. Wells St., Chicago, Ill.
Federal Screw Products Inc., 3917 N. Kedzie Ave., Chicago, Ill.
General Dry Batteries Inc., Cleveland, Ohio
Marshall Electronics Co., 54 Summer Ave., Newark, N. J.
Precision Rubber Products Corp., 3110 Oakridge Drive, Dayton, Ohio
Pyramid Electric Corp., 1445 Hudson Blvd., N. Bergen, N. J.
Radio Frequency Laboratories, Boonton, N. J.

8.4 Recommended Maintenance Spare Parts List

Parts recommended for five units for one year based on 300 hours of operation.

Quantity	*Item*
10	BAT-1,2 Battery, "D" cell 1.5V General #107
15	BAT-3,4,5 Battery, "B" 45V General #150
1	M-1 Meter Chatham #10794
1	V-1 Geiger-Mueller tube Amperex #85NB
2	V-2,6,7 Tube, pentode Amperex #6007
1	V-4 Tube, pentode Amperex #6007A
1	V-3, 5 Tube, neon Marshall Electronics #NE-7
1	L-1 Choke, special Chatham #10799
1	SW-1 Switch, selecting Chatham #10781
1	R-1 thru R-9, C-1 thru C-3 Printed component card Chatham #10855
1	C-5 thru C-7 Printed component card Chatham #10856
1	R-14, 15, C-9 Printed component card Chatham #10857
1	R-16 thru R-21, C10,11 Printed component card Chatham #10917-8
1	C-4 Capacitor, 10μf Astron #ET-10-25
1	C-8,12 Capacitor, 0.25μf Pyramid #100-TRR—Special
1	C-13,14 Capacitor, 0.01μf Centralab #GMV
1	R-13 Potentiometer, calibrating Centralab #26-4294-1
1	Earphone assembly Chatham #10792
2	Gasket, cover Chatham #10859
1	Gasket, meter Precision #914-37-C-750-70
1	Gasket, mounting screw Precision #902-3-C-750-70
2	Boot, switch R.F. Lab. #H-1268
6	Tubing, deck mounting Chatham #10783
6	Clip, deck mounting Chatham #10854
1	Battery wire assembly Chatham #10790
1	Battery deck assembly Chatham #10603
1	Carrying strap assembly Chatham #10534

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